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Analyzing companies' interactions with the Sustainable Development Goals through network analysis: Four corporate sustainability imperatives

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Abstract

The alignment between corporate strategies and the Sustainable Development Goals (SDGs) can be an indicator of long-term sustainability success. But which types of companies are most, and which are least, aligned with the SDGs? This paper scores how 67 economic activities—as a proxy for companies' operations and the goods or services they deliver—interact with 59 SDG targets. It then uses network analysis to define which activities are most and least aligned with the SDG Agenda. The results reveal four types of corporate activities, each having a strategic sustainability imperative: (i) "core activities" predominantly generate positive, while having few negative, impacts on the SDGs, challenging companies to scale their contributions to further align with the SDG Agenda; (ii) "mixed activities" have moderate/high degrees of both negative/positive impacts, posing a decoupling imperative; (iii) "opposed activities" provide few benefits yet cause significant adverse impacts, implying that companies must transform in order to better align with the SDGs; and (iv) "peripheral activities" have immaterial positive and negative impacts, creating an imperative to explore innovative avenues for creating SDG contributions. Detailed network graphs are presented that map companies' interactions with the SDGs and guide the creation of corporate sustainability strategies. Policy implications include the potential for using companies' activities as a lever for adopting a "nexus approach" to the SDGs.

KEYWORDS

corporate sustainability, economic activity, network analysis, SDG interactions, shared value, sustainable development, Sustainable Development Goals (SDGs), 2030 Agenda for Sustainable Development

1 | INTRODUCTION

The Sustainable Development Goals (SDGs) aim to "transform our world." The 17 SDGs with 169 underlying targets were adopted by all 193 United Nations (UN) member states, forming a "blueprint for shared prosperity in a sustainable world—a world where all people can live productive, vibrant and peaceful lives on a healthy planet" (UN, 2019:2). And in addition to shaping national policies, the SDGs aim to influence corporate strategies. The UN resolution outlining the SDGs formally states "Governments, international organizations, the

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business sector and other non-State actors and individuals must contribute to changing unsustainable consumption and production patterns … We call upon all businesses to apply their creativity and innovation to solving sustainable development challenges" (UN, 2015:8, 29).

Since companies impact the SDGs they are critical for success. However, although the role of companies in the SDGs is gaining a lot of traction in academic research (e.g., Kolk et al., 2017; Mio et al., 2020; Pizzi, Caputo, et al., 2020; Pizzi, Rosati, & Venturelli, 2020; Sinkovics, Sinkovic, & Archie-Acheampong, 2021; van Tulder, 2018; van Zanten & van Tulder, 2018, van Zanten & Van Tulder, 2020a; Witte & Dilyard, 2017), few studies have investigated how companies impact the goals and their underlying targets. If progress towards achieving the SDGs is to be accelerated, the private sector's impacts on sustainable development need to be better understood (cf. van Zanten & van Tulder, 2020a, 2020b). This not only is relevant for informing how these global goals might be advanced at a policy (macro) level. It also offers relevant inputs for creating business strategies that improve corporate impacts on sustainable development (at a micro-level).

Since all countries agreed to work towards achieving the 17 SDGs by 2030, these goals now comprise the leading frame for sustainable development (e.g., Sachs, 2015), making them part of companies' institutional environments (cf. van Zanten & van Tulder, 2018). Strategic management researchers have extensively studied the relationships between companies and their environments. The consensus is that companies that are able to coevolve with their environment are expected to be more successful compared to those that fail to adapt to changes in their environment (e.g., Brown & Eisenhardt, 1997; Lewin et al., 1999; March, 1991; Raisch & Birkinshaw, 2008; Volberda, 1996; Volberda & Lewin, 2003). Transposing these insights to the level of corporate sustainability,[1] it can be proposed that the degree of alignment between corporate strategies and the SDGs is an important indicator of sustainability success. Companies that generate positive impacts that help attain the SDGs can be considered as more sustainable than companies whose impacts impede progress towards the goals. Hence, the SDGs provide a benchmark that helps to discriminate to what extent companies are aligned with their sustainable development context.

This proposition resonates in practice where many, particularly large, companies are choosing the SDGs as a benchmark of sustainability success. Currently, some 72% of large companies report on the goals (PwC, 2019). Voluntary initiatives like the UN Global Compact, the Principles for Responsible Investment, and the World Business Council for Sustainable Development also actively encourage their members to contribute to achieving the SDGs. However, most companies adopt gradual strategies that slowly try to align with the SDGs, with far fewer companies creating transformative strategies that are more likely to secure long-term sustainability success. To illustrate, out of 1000 companies assessed by PwC, only 25% include the SDGs in their strategy, with just 14% mentioning specific SDG targets (PwC, 2019). Moreover, most companies situate the SDGs in their Corporate Social Responsibility (CSR) or corporate communications departments (PwC, 2018). And while many are happy to report positive impacts, few examine their negative impacts on the SDGs (WBCSD and DNV-GL, 2018). It is therefore not surprising that, out of 1000 surveyed CEOs, only 21% feel that business is currently playing a critical role in contributing to the SDGs (UN Global Compact & Accenture Strategy, 2019).

A requirement for long-term sustainability success is thus for companies to align their activities with the ambitions of the SDGs. However, companies' activities are varied and assessing their impacts on sustainable development requires a nuanced approach. Sinkovics et al. (2021) disentangle this complexity by introducing a matrix that categorizes four corporate activities, each of which may be positively, neutrally, or negatively linked to particular SDGs. First, "associative" activities refer to a firm's involvement in networks related to a specific cause. Second, "peripheral" activities are the voluntary actions a company may undertake to support a sustainability objective, beyond its core activities. Third, "operational" activities describe the firm's processes. Finally, "embedded" activities encompass the company's products and services (see Sinkovics et al., 2021 for a discussion). Although this discussion underscores that companies can impact the SDGs through various types of activities, the products and services that a company creates, and the processes through which they are made and distributed, are at the core of "economic activity" and thus likely to account for the lion share of a company's impacts on the SDGs (Sinkovics et al., 2021; van Zanten & van Tulder, 2020a).

This raises a critical question: which types of companies are most, and which are least, aligned with the ambitions of the SDG Agenda? Companies undertake a myriad of "economic activities" to produce and distribute goods and services. These economic activities may positively and negatively impact the SDGs and their targets—often at the same time. The strategic alignment challenge then becomes to assess the net effects of companies' economic activities on the whole SDG Agenda. To give three simplified examples at the level of individual companies: (i) agricultural producers help feed the world yet also are large consumers of freshwater resources, they degrade natural habitats, and use fertilizers and pesticides that pollute rivers and oceans; (ii) pharmaceutical manufacturers play a key role in promoting health but their processes are chemical intensive and pollute water; and (iii) renewable energy providers promote access to energy, help mitigate climate change, and can consequently positively support ecosystems, while having few, if any, adverse impacts on the SDGs (e.g., van Zanten & van Tulder, 2020a). Only when we understand what the positive and negative impacts are of a company's operations ("operational activities") and the goods and services it delivers ("embedded activities") can we think about how the company might achieve long-term sustainability success by improving its alignment with the SDG Agenda through adaptive or more transformative strategies.

This paper studies the alignment of different types of economic activities, used as an umbrella term that includes companies' operations as well as the created goods or services, with the SDG Agenda. We identify 67 unique economic activities and assess to what extent they positively and/or negatively interact with 59 SDG targets. These 67 economic activities apply at the sectoral (meso-level). Since they

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serve as indications of companies' operations and the goods or services that are created, these economic activities can be used as a proxy for better understanding the heterogeneous influence of the private sector on sustainable development. This recognizes that we are in need of a more fundamental approach that partly abstracts from individual corporate strategies and instead problematizes the more general impacts of economic activities (meso-level/network) on the SDGs (macro-level). To assess the interactions between these 67 economic activities and 59 SDG targets, we use a qualitative scoring framework that draws from recent studies that seek to conceptualize and establish interactions between the SDGs themselves (e.g., Nilsson et al., 2016, 2018; Weitz et al., 2018). To assess the alignment of each of these economic activities with the SDG Agenda, we then adopt mathematical techniques from network theory to study the scored interactions as a network. Network theory allows for disentangling the interactions between firms and their environments, which is a promising approach that can "invigorate the relevance of management studies in a changing world" (Casciaro, 2020:6).

The results reveal indications of *centrality* and *similarity*: (i) which economic activities are most central in terms of impacting most SDG targets; (ii) which economic activities are similar in terms of impacting the same SDG targets; (iii) which SDG targets are most central by being most frequently impacted by economic activities; and (iv) which SDG targets are most similar by virtue of being impacted by the same economic activities. Our results inform to what extent companies pursuing different activities are positively and negatively aligned with the SDG Agenda. This creates critical inputs for corporate sustainability strategies that seek to improve a company's alignment with the SDGs and to thereby attain long-term sustainability success. We distinguish between four types of economic activities, each of which is associated with a strategic imperative: (i) activities that are "core" to the SDG Agenda generate significant positive and few negative impacts, implying that companies must seek to *scale* their positive impacts to further align with the SDG Agenda; (ii) "mixed" activities generate significant positive and negative impacts on the SDGs, posing an imperative to *decouple* these; (iii) "opposed" activities generate significant negative, and less significant positive, impacts on the SDGs, implying that companies must *transform* in order to better align with the SDGs; and (iv) peripheral activities have relatively insignificant positive and negative effects, creating an imperative to *explore* ways for generating positive impacts.

These results contribute to the strategic management and sustainable business innovation literature in a number of ways. Extant literature suggests various strategies that companies can employ to improve their impacts on societies and the environment. But most of these studies have found it hard to develop appropriate metrics that can successfully lead to reaching complex sustainability goals, while acknowledging the trade-offs between corporate activities and these goals. One of the most popular strategic management approaches in this discourse has been the idea of "creating shared value," which aims to align company success with social progress (Porter & Kramer, 2006, 2011). In this approach, companies are supposed to "fix" capitalism by "creating economic value in a way that also creates value for society by addressing its needs and challenges" (Porter & Kramer, 2011:65). The shared value concept builds on earlier ideas like "blended value" (Emerson, 2000), the "triple bottom line" (Elkington, 1997) or the "bottom of the pyramid" strategy (Prahalad, 2005). The significant traction each of these strategic approaches gained, in theory and in practice (Van Tulder, 2018), underscores that it is well recognized that strategic management is pivotal to improving the impacts of companies on sustainable development. However, this literature also faces significant gaps. One the one hand, such strategic approaches adopt a general perspective, paying little, if any, attention to the different types of economic activities that companies may undertake. In this view, companies are often treated as monolithic entities (or black boxes), that are advised to generically adopt the same type of sustainability strategy, thereby ignoring the diversity of activities different companies may undertake. On the other hand, many dominant strategic management approaches narrowly focus on improving companies' positive impacts, thus conveniently ignoring negative externalities (cf. Crane et al., 2014; Dembek et al., 2016), which made them susceptible to serious critique for being either too positive or even naive. This paper aims to make a fundamental contribution to this discourse by arguing that strategies that aim to (measurably) have an impact on sustainable development, as exemplified by the SDGs, need to appreciate the heterogeneity of activities that companies may pursue, as each activity can generate positive and negative impacts on various SDGs. Corporate strategies for improving the degree of alignment between a company and the SDGs—thus creating shared value—are likely to become more effective if they depart from the actual impacts—positive and negative—of that company's activities on the entire SDG Agenda.

Although this paper is framed in the context of corporate strategic approaches to sustainable development, the results also yield insights for policymakers aiming to drive progress towards achieving the SDGs. This study's assessment of economic activities' impacts on the SDGs' targets contribute a meso-level perspective to the policy discourse—with its dominant focus on macro-level interventions. The poor experience with specific interventions (for instance through selective industrial and technology policies that tried to advance particular industries or technologies), have reinforced the search for general—often neo-liberal policies—with a top–down "one-size-fits-all" approach. The complexity of the SDG framework has likewise precipitated policymakers to design generic macro-economic strategies. The efficiency and effectiveness of such generic top–down policies can be seriously questioned. They are unable to steer on the complex interconnectedness of sustainable development and thus fail to take spill-over, networking, and substitution effects of policies into account (e.g., Bennich et al., 2020; Boas et al., 2016; Obersteiner et al., 2016; Scharlemann et al., 2020). Overly generic policy approaches are part of the explanation why progress towards achieving the SDGs is too slow (UN, 2020; van Zanten & van Tulder, 2020b). These findings reiterate the urgency for developing more sophisticated policy responses, that integrate different levels of analysis (i.e., the macro-, meso-, and micro-levels) and the way they interact. By assessing how corporate activities impact diverse SDGs, this paper provides inputs for policies

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that steer towards attaining the (macro) SDGs by leveraging economic activities (at the meso-level) and the companies that undertake them (at the micro-level).

The remainder of this paper is organized as follows: Section 2 presents our methodology for identifying and subsequently analyzing the interactions between economic activities and SDG targets using techniques from network theory. The results are presented in Section 3, revealing detailed network graphs showing the extent to which economic activities align with the SDGs. In Section 4 we raise implications for strategic management and for public policy. We also discuss the study's limitations and delineate avenues for further research. Finally, Section 5 offers concluding remarks.

2 | METHODOLOGY

This section first describes how we selected 67 economic activities—as a standardized indication of the core activities that companies undertake—and 59 SDG targets. Then, we explain how we defined and subsequently analyzed the interactions between them.

2.1 | Defining the scope: Economic activities and SDG targets

First, to select economic activities for inclusion in the study, our starting point was the International Standard Industrial Classification of All Economic Activities, Rev. 4 (ISIC) published by the UN Statistics Division (UNSTATS). ISIC classifies economic activities into 21 sections (Level 1), 88 divisions (Level 2), 238 groups (Level 3), and 420 classes (Level 4), thereby offering "a basic tool for studying economic phenomena, fostering international comparability of data, providing guidance for the development of national classifications" (UNSTATS, 2007). This standardized list of economic activities can be argued to be a relevant proxy for companies' core activities. This is underscored by the prevalence of such classifications in extant datasets on the private sector. For instance, rankings of the world's largest companies (e.g., FT 500) and on the world's most sustainable companies (e.g., Dow Jones Sustainability Index), but also the financial data that is provided by agents such as MSCI, S&P, Bloomberg, or Sustainalytics, use standardized classifications of economic activities to shed light on what types of activities companies undertake.

Taking the ISIC classification (see UNSTATS, 2007, for the entire list) as a starting point, we had to decide which particular activities to include in our study. To that end, we assessed the entire classification, aiming to derive a representative list of specific economic activities that offered the level of granularity required for mapping interactions with SDGs (as in many cases the sections were too generic), while at the same time avoiding the inclusion of numerous, highly similar activities (as the economic classes typically were too granular for our purposes). To this end, we started by taking each of ISIC's 21 sections and asked whether it is a good representation of all divisions, groups, and classes belonging to it. If so, we took the section. If not, we moved down one level and asked whether this division was representative of its underlying groups and classes. A positive answer led us to include the division whereas a negative answer made us repeat the process at the next level down. To illustrate, we decided that the section "Education" sufficiently represented its underlying divisions. In contrast, for the section "Financial and insurance activities" we decided to include two divisions, one for financial and one for insurance activities.

Finally, we removed economic sections that were purely focused on the public sector (i.e., "Public administration and defense; compulsory social security" and "Activities of extraterritorial organizations and bodies") and economic activities whose implications for sustainable development are hard to attribute due to their generic nature, at the levels of sections (i.e., "Other service activities" and "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use") and divisions, groups, and classes.

The obtained list of 67 economic activities is shown in Table 1. The table also lists the summarized names and sector numbers, which are referred to in some of this paper's figures.

Second, we aimed to derive a representative list of SDG targets that may be influenced by these economic activities. Because the SDGs' targets are much more detailed than the overarching goals, a target-based analysis enhances the richness of insights (van Zanten & van Tulder, 2018) and allows interactions in a network to be more easily discerned (Weitz et al., 2018).

Because there are 169 SDG targets, Weitz et al. (2018) advise to work with a sub-selection in order to avoid feasibility constraints. Following the method of van Zanten and van Tulder (2018), we reduced this list to 59 SDG targets by (1) removing SDG 17, since it is an overarching goal dedicated to strengthening the means of implementation; (2) working with the 107 substantive targets (those that are numbered) of SDGs 1–16, thereby removing "means of implementation" targets (those that are lettered); and (3) excluding targets which could not significantly be foreseen to be impacted by economic activities. We adopted an inclusive approach and intended to ensure good coverage across the SDGs. These 59 targets cover 55% of all substantive targets belonging to these 16 SDGs and, for 11 of the 16 SDGs, the selected targets cover over 55% of their official substantial targets (Table 2).

2.2 | Defining interactions between economic activities and SDG targets

We assessed each of the interactions between economic activities and SDG targets. The selection of economic activities and SDG targets renders a total of 3953 interactions to be analyzed (67×59). Economic activities can have diverse interactions with SDG targets and there is a need to go beyond a simple dichotomy of positive and negative effects (cf. Weitz et al., 2018).

To account for the multiplicity of interactions, we used the SDG interactions framework created by Nilsson et al. (2016). This

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TABLE 1 Economic activities included in this study

Number	Economic activity	Summarized name
1	Growing of non-perennial crops	A. Crops (n-p)
2	Growing of perennial crops	A. Crops (p)
3	Animal production	A. Animals
4	Forestry and logging	A. Forestry
5	Fishing	A. Fishing
6	Aquaculture	A. Aqua
7	Mining of coal and lignite	M. Coal
8	Extraction of crude petroleum	M. Petrol
9	Extraction of natural gas	M. Gas
10	Mining of metal ores	M. Metal
11	Quarrying of stone, sand, and clay	M. Quarrying
12	Manufacture of food products	Mf. Food
13	Manufacture of sugar and bakery products	Mf. Sugar
14	Manufacture of alcohol and tobacco products	Mf. Alcohol
15	Manufacture of soft drinks	Mf. Drinks
16	Manufacture of textiles, leather, and wearing apparel	Mf. Textiles
17	Manufacture of wood and paper products	Mf. Wood
18	Manufacture of coke and refined petroleum products	Mf. Coke
19	Manufacture of fertilizers, pesticides, and other agrochemical products	Mf. Fertilizer
20	Manufacture of soap and detergents	Mf. Soap
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Mf. Pharma
22	Manufacture of rubber, plastics, and glass products	Mf. Plastics
23	Manufacture of cement, lime, and plaster	Mf. Cement
24	Manufacture of basic metals	Mf. Metals
25	Manufacture of weapons and ammunition	Mf. Weapons
26	Manufacture of computer, electronic, and optical products	Mf. Computer
27	Manufacture of agricultural and forestry machinery	Mf. A. Mach
28	Manufacture of machinery for mining, quarrying, and construction	Mf. M. Mach
29	Manufacture of motor vehicles	Mf. Motor
30	Manufacture of railway locomotives and rolling stock	Mf. Rail
31	Manufacture of medical and dental instruments and supplies	Mf. Medical
32	Non-renewable electric power generation, transmission, and distribution	U. Power (n-r)
33	Renewable electric power generation, transmission, and distribution	U. Power (r)
34	Water collection, treatment, and supply	U. Water
35	Sewerage	U. Sewerage
36	Waste collection, treatment, and disposal activities; materials recovery	U. Waste
37	Construction of buildings	C. Buildings
38	Construction of roads and railways	C. Roads
39	Construction of utility projects	C. Utility
40	Wholesale trade	W. Wholesale
41	Retail sale of food products	R. Food
42	Retail sale of beverages and tobacco products	R. Beverages
43	Retail sale of automotive fuel	R. Fuel
44	Retail sale of information and communications equipment	R. ICT
45	Retail sale of clothing, footwear, and leather articles	R. Clothing
46	Retail sale of pharmaceutical and medical goods	R. Pharma

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TABLE 1 (Continued)

Number	Economic activity	Summarized name
47	Passenger rail transport	T. Rail (p)
48	Freight rail transport	T. Rail (f)
49	Transport via roads	T. Road
50	Water transport	T. Water
51	Air transport	T. Air
52	Accommodation	S. Accommodation
53	Food and beverage service activities	S. F&B
54	Information and communication	S. IT
55	Financial service activities	S. Financial
56	Insurance	S. Insurance
57	Real estate activities	S. Real estate
58	Legal activities	S. Legal
59	Architectural and engineering activities	S. Architecture
60	Scientific research and development	S. Science
61	Activities of employment placement agencies	S. Employment
62	Travel agency, tour operator, reservation service, and related activities	S. Travel
63	Security and investigation activities	S. Security
64	Education	S. Education
65	Human health and social work activities	S. Health
66	Arts, entertainment, and recreation	S. Arts
67	Repair of computers and personal and household goods	S. Repair

TABLE 2 SDG targets included in this study

SDG	Substantive targets included	% of the SDG's substantive targets included
1. No poverty	1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership, and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services, including microfinance 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks and disasters	40%
2. Zero hunger	2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious, and sufficient food all year round 2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters and that progressively improve land and soil quality	60%
3. Good health and well-being	3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases	56%

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TABLE 2 (Continued)

SDG	Substantive targets included	% of the SDG's substantive targets included
	3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	
	3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	
	3.7 By 2030, ensure universal access to sexual and reproductive health care services, including for family planning, information, and education, and the integration of reproductive health into national strategies and programs	
	3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health care services and access to safe, effective, quality, and affordable essential medicines and vaccines for all	
	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination	
4. Quality education	4.1 By 2030, ensure that all girls and boys complete free, equitable, and quality primary and secondary education leading to relevant and effective learning outcomes	57%
	4.2 By 2030, ensure that all girls and boys have access to quality early childhood development care and pre-primary education so that they are ready for primary education	
	4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education, including university	
	4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development	
5. Gender equality	5.1 End all forms of discrimination against all women and girls everywhere	33%
	5.2 Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation	
6. Water and sanitation	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	67%
	6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	
	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	
	6.4 By 2030, substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	
7. Affordable and clean energy	7.1 By 2030, ensure universal access to affordable, reliable, and modern energy services	67%
	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	
8. Decent work and economic growth	8.2 Achieve higher levels of economic productivity through diversification, technological upgrading, and innovation, including through a focus on high-value added and labor-intensive sectors	70%
	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and encourage the formalization and growth of micro-, small-, and medium-sized enterprises, including through access to financial services	

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TABLE 2 (Continued)

SDG	Substantive targets included	% of the SDG's substantive targets included
	8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programs on sustainable consumption and production, with developed countries taking the lead	
	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	
	8.8 Protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	
	8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	
	8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance, and financial services for all	
9. Industry, innovation, and infrastructure	9.1 Develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	80%
	9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries	
	9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets	
	9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	
10. Reduced inequalities	10.2 By 2030, empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status	29%
	10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies, and practices and promoting appropriate legislation, policies, and action in this regard	
11. Sustainable cities and communities	11.1 By 2030, ensure access for all to adequate, safe, and affordable housing and basic services and upgrade slums	57%
	11.2 By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons	
	11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage	
	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	
12. Responsible production and consumption	12.2 By 2030, achieve the sustainable management and efficient use of natural resources	63%
	12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	
	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water, and soil in order to minimize their adverse impacts on human health and the environment	

(Continues)

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TABLE 2 (Continued)

SDG	Substantive targets included	% of the SDG's substantive targets included
	12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse 12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	
13. Climate action	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.2 Integrate climate change measures into national policies, strategies, and planning[a] 13.3 Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning	100%
14. Life below water	14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution 14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported, and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	29%
15. Life on land	15.1 By 2020, ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains, and drylands, in line with obligations under international agreements 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought, and floods, and strive to achieve a land degradation-neutral world 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity, and, by 2020, protect and prevent the extinction of threatened species 15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products	56%
16. Peace, justice, and strong institutions	16.1 Significantly reduce all forms of violence and related death rates everywhere 16.3 Promote the rule of law at the national and international levels and ensure equal access to justice for all 16.4 By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets, and combat all forms of organized crime 16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements	40%

[a]SDG 13 aims to advance "Climate Action" and refers to the Paris Agreement, which was agreed in December 2015, 3 months after the world agreed on the SDGs. Having been agreed before the Paris Agreement, the SDGs contain no concrete targets for climate change mitigation. In this study, we view SDG target 13.2 as relating to climate change mitigation efforts.

framework provides a typology and scoring of the interactions between SDG targets on a seven-point scale, indicating expected effects of progress of one SDG target on another. The framework distinguishes between three types of positive interactions (i.e., enabling (+1), reinforcing (+2), or indivisible (+3)), neutral interactions (0), and three types of negative interactions (i.e., constraining (−1), counteracting (−2), or canceling (−3)) (cf. Nilsson et al., 2016). This framework has been applied in empirical studies, for instance by ICSU (2017) to qualitatively map interactions between SDGs, and by Weitz et al. (2018) to map interconnections between 34 SDG targets in the context of Sweden. We adapted the framework (Table 3) in order to assess the uni-directional interconnections between economic activities and SDG targets.[2]

Using this scoring framework, we created an incidence matrix that scores interconnections between the 67 economic activities (rows) and the 59 SDG targets (columns). Because identification of interconnections depends on context variables and assumptions about them (Nilsson et al., 2016), we created particular

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TABLE 3 Seven-point typology of interactions between economic activities and SDGs

Type	Interaction	Name	Explanation	Example
Positive	3	Indivisible	An economic activity is inextricably linked to the achievement of an SDG	Renewable energy generation is indivisible from the objective of increasing the share of renewable energy in the global energy mix (SDG target 7.2)
	2	Reinforcing	An economic activity aids the achievement of an SDG	Manufacture of soap and detergents reinforces ending the spread of communicable diseases (SDG target 3.3)
	1	Enabling	An economic activity creates conditions that enable achievement of an SDG	Construction of buildings enables improving people's access to adequate and safe housing (SDG target 11.1)
Neutral	0	Consistent	An economic activity does not significantly—positively or negatively—interact with an SDG	Legal services do not significantly interact with the provision of quality education (SDG 4)
Negative	−1	Constraining	An economic activity limits options to achieve an SDG	Real estate activities constrain the objective of improving water use efficiency (SDG target 6.4)
	−2	Counteracting	An economic activity clashes with an SDG	Water transport releases air pollutants, counteracting health objectives (SDG target 3.9)
	−3	Canceling	An economic activity makes it impossible to achieve an SDG	Mining coal and lignite cancel the ability to achieve the climate change mitigation goals outlined in the Paris agreement (SDG target 13.2)

Note: Adapted from Nilsson et al. (2016).

assumptions to guide the scoring exercise and to reduce the risk of subjectivity. As Nilsson et al. (2018) note, in scoring interactions in the context of the SDGs there is a need for transparency about assumptions.

To score the interactions of companies' economic activities on SDG targets, we ask the question: "If a company engages in this particular economic activity x (rows), how does this influence progress on SDG target y (columns)?" whereby we abide by the following assumptions:

I. *Intrinsic:* We only record interconnections caused by the intrinsic nature of the economic activity, not those that might arise from management. For instance, "mining activities" are *intrinsically* expected to negatively interact with the preservation of land-based ecosystems and biodiversity (SDG target 15.5). Such activities may be *managed* in ways that minimize these negative environmental impacts and rehabilitate the ecosystem after the mine's life cycle (and they could be *managed* in ways that promote other SDGs, like gender equality (SDG 5)). This study only looks at the expected intrinsic impacts of economic activities, regardless of how they are potentially managed;
II. *Universal:* We assign interactions if they are expected to arise across different countries. The above example of the interactions between "mining activities" and SDG target 15.5 is expected regardless of whether the activity is executed in Switzerland or Swaziland. While we acknowledge the influence of national factors such as countries' institutional environments, their income levels, and their resource endowments, on interactions between economic activities and SDG targets, we intend to shed a first light on the universal effects of economic activities on the SDG agenda.

Guided by these assumptions, we scored the interconnections in the incidence matrix through three related methods:

First, we assessed the wording of the 59 SDG targets included in the study to identify which types of economic activities are called for by the targets. For example, SDG 3.8 seeks to improve people's access to health care services and medicines, which is a direct call for the involvement of the health services (including hospitals) and pharmaceutical sectors. In such cases we defined positive interactions between economic activities and SDG targets, in line with similar endeavors that mapped interactions among the SDG targets based on their wording (e.g., Le Blanc, 2015).

Second, we followed the systematic-type literature review conducted by van Zanten and Van Tulder (2020a). This study synthesized interactions between economic activities (also using the ISIC classification) and SDG targets, as reported in 876 academic and gray articles published between 2005 and 2019. We scored the interactions defined by this literature review. By building on extant literature we gained access to a wide variety of well-founded insights. This was critical for reducing the subjectivity involved in the scoring exercise and for enhancing the replicability of this study.

Third, we liaised with external experts to create a degree of inter-rater reliability by validating the strength of linkages defined. In total, we consulted 18 experts. Two groups of experts (consisting of eight and seven individuals employed as sector and sustainability experts in the financial sector) offered feedback on the defined interactions

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during half day workshops. The remaining three experts provided feedback on a continuous basis. The feedback of the experts primarily informed which strength to assign to an interaction, rather than whether the interaction should be drawn or not (which was established based on the two methods above).

Following Weitz et al. (2018), we cross-checked the scores, provided explanations for scores that were not straightforward, and in some cases adjusted scores during this iterative process. Although the scores remained qualitative transcriptions of expert judgments, basing them on an assessment of the SDGs' targets, extant literature, and external expert opinions mitigated the extent of the subjectivity inherent to this study.

2.3 | Analyzing interactions using network theory

We quantitatively analyzed the identified interactions using techniques and methods from *network theory*. A network (G)—or graph in the mathematical literature—is a collection of nodes (N) (or vertices) joined by edges (M) (also called links or interactions), so that G(N,M) (Newman, 2018).

The 67 × 59 incidence matrix that we developed shows the identified and scored interactions between economic activities (67) and SDG targets (59). This incidence matrix can be represented as a bipartite network (also called a two-mode network), since it incorporates two kinds of nodes with edges that only connect nodes of different kinds (i.e., economic activities and SDG targets). Moreover, the network is directed and weighted, meaning that the interconnections flow *from* economic activities *to* SDG targets (direction), whereby the interconnections have different strengths (weight). By employing tools from network theory, we gained also more quantitative insights into the degree of (positive and negative) alignment of individual economic activities with the SDG Agenda.

The data were analyzed using Microsoft Excel. We use Gephi software[3] to visualize the estimated networks of interactions between economic activities and SDG targets.

3 | RESULTS

How is progress on SDG targets influenced by the economic activities companies undertake? Our method results in an "impact matrix" which creates the backbone of this study (Section 3.1). The matrix enables in-depth network analysis of the net alignment between economic activities and SDG targets (Section 3.2).

3.1 | Impact matrix

Our analysis departs from the impact incidence matrix that scores interactions between 67 economic activities and 59 SDG targets. The scoring reveals how progress on SDG targets (columns) is expected to be influenced by the particular economic activities (rows) companies engage in. Figure 1 is the resulting incidence matrix showing the 3953 interactions that were analyzed. In the matrix, colors correspond to the scores that were used, ranging from dark red (−3 = canceling) to dark green (+3 = indivisible).

Slightly more positive (225) than negative (214) interactions were identified. The remaining and predominant share of interactions (3514; 89% of total) are neutral. Of the positive interactions, 57% are characterized as "enabling" (+1), 19% as "reinforcing" (+2), and 24% as "indivisible" (+3). Conversely, 46% of negative interactions are "constraining" (−1), 52% "counteracting" (−2) and 2% "canceling" (−3).

The matrix in Figure 1 sums the rows as an indication of the net influence an economic activity exerts on all SDG targets. It similarly sums the columns, indicating the net influence a SDG target receives from all economic activities. We find that economic activities with the most positive influence on SDG targets are "Human health and social work activities" and "Education." In contrast, "mining of coal, lignite and extraction of natural gas" and "quarrying of sand, stone, and clay" exert the most negative net influence on the SDGs. And whereas SDG target 9.2 (promotion of industrialization) benefits the most from economic activities, target 13.2 (mitigation of climate change) receives the most net negative influence from economic activities.

As Weitz et al. (2018) note, such net influence scores provide an impression of the identified interactions, though offer limited insights into the dimensions of the underlying interactions. An economic activity can have a high score by having few but important, or many but less significant, interactions with SDG targets. Similarly, an economic activity may simultaneously have many positive and negative interactions, indicating it has an important role in the SDG agenda, yet still have a net influence score of around zero as pluses and minuses balance one another. This logic holds equally for the net influence scores of SDG targets (columns). Hence there is a need to further analyze these interactions.

3.2 | Assessing interactions through network analysis

The incidence matrix contains diverse types of information. It shows that economic activities generate positive, neutral, and negative influences on multiple SDG targets. There are big differences between economic activities in their influence on the SDGs. The same variations apply to SDG targets: Some are supported by many economic activities, some are degraded by many, and others receive few influences. To obtain a better understanding of these interactions we apply network analysis.

As a first step, Figure 2 visualizes the interactions identified in the incidence matrix as a bipartite network of two groups of nodes: economic activities shown as gray nodes, and SDG targets shown in colored nodes, with their color corresponding to the SDG logos. The color of the interactions (edges) between the nodes denotes positive (green) or negative (red) impacts. The interactions' strength is

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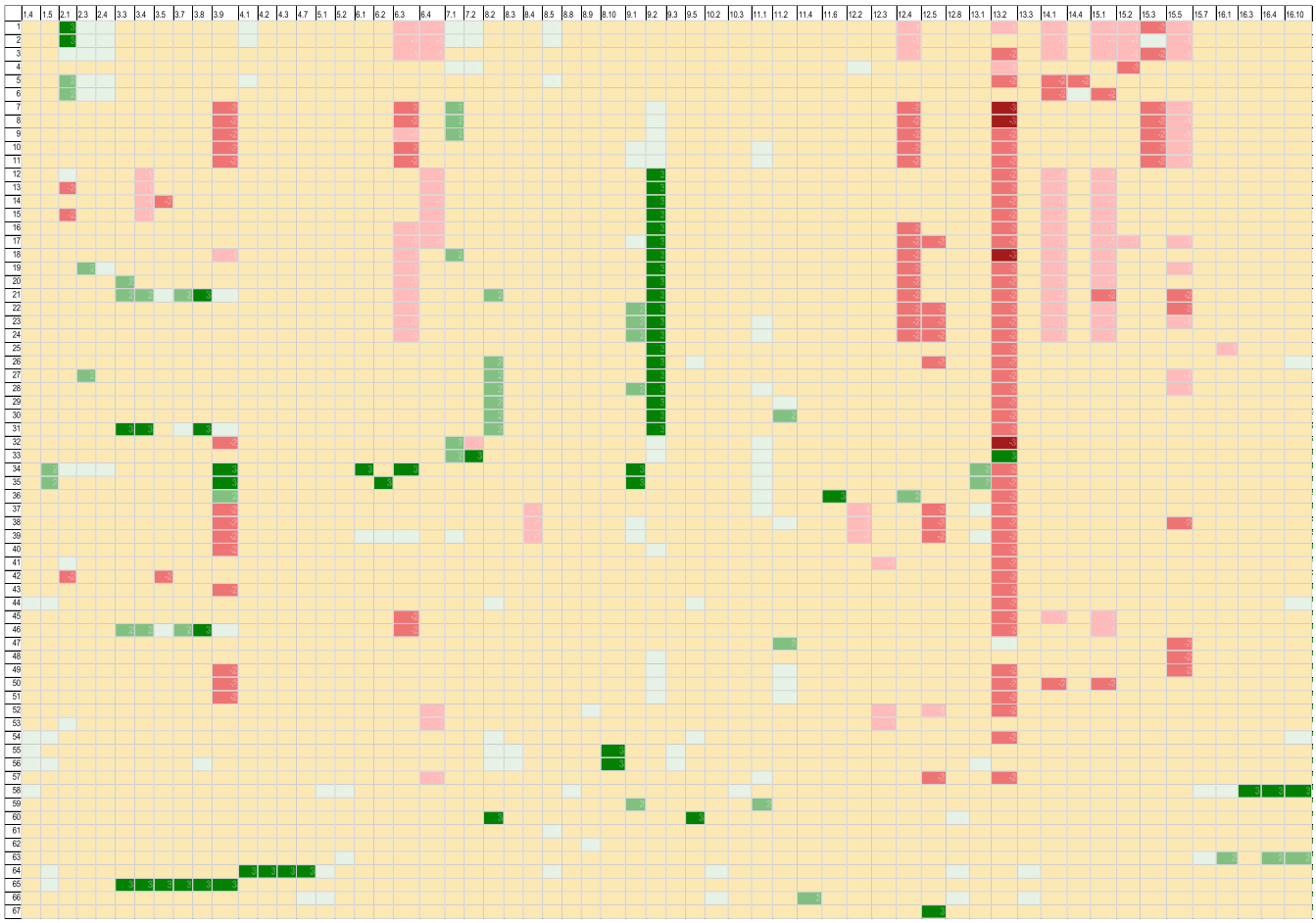

FIGURE 1 Incidence matrix [Colour figure can be viewed at wileyonlinelibrary.com]

indicated by the width of the interactions (ranging from 1 to 3). In total, it visualizes 439 interactions between 126 nodes (67 economic activities and 59 SDG targets).

This first visualization of the matrix conveys that (i) the interrelations between economic activities and SDG targets are many and complex, and (ii) deeper analysis is needed to understand to what extent specific economic activities are positively and negatively aligned with the entire SDG Agenda.

3.2.1 | Centrality: Which economic activities and SDG targets are most central?

Figure 2 shows that economic activities differ in terms of the number of SDG targets that they impact, and conversely that SDGs vary in terms of the number of sectors that they are influenced by. The concept of *degree centrality* sheds light on which nodes in a network are most important, by virtue of their influencing (or being influenced by) many other nodes. We calculated the out-degree centrality of economic activities and the in-degree centrality of SDG targets by summing each economic activity's out-going interactions and each SDG target's ingoing interactions.

To do so, we transformed our incidence matrix in order to only look at whether there is an interaction between an economic activity and an SDG target. Hence, this changed our weighted interactions to binary—yes/no—interactions. With this transformed incidence matrix (*A*), we calculated the degree centrality for given nodes i and j as follows, distinguishing between the out- and in-degree:

$$k_i^{out} = \sum_{j=1}^{59} a_{ij} \qquad \text{and} \qquad k_j^{in} = \sum_{i=1}^{67} a_{ij}$$

where element a_{ij} of incidence matrix *A* indicates a 1 if there is an interconnection from economic activity *i* to SDG target *j*.

We used the obtained measures of out-degree centrality (of economic activities) and in-degree centrality (of SDG targets) to update the visualization of the network. In Figure 3, the size of the nodes correlates with the extent to which economic activities influence SDG targets and vice versa.

So, which economic activities exert most influence on the SDG Agenda? We find that "Growing of non-perennial crops" has the highest out-degree centrality as it interacts with 16 SDG targets. This is followed by "growing of perennial crops" (k^{out} = 15), and

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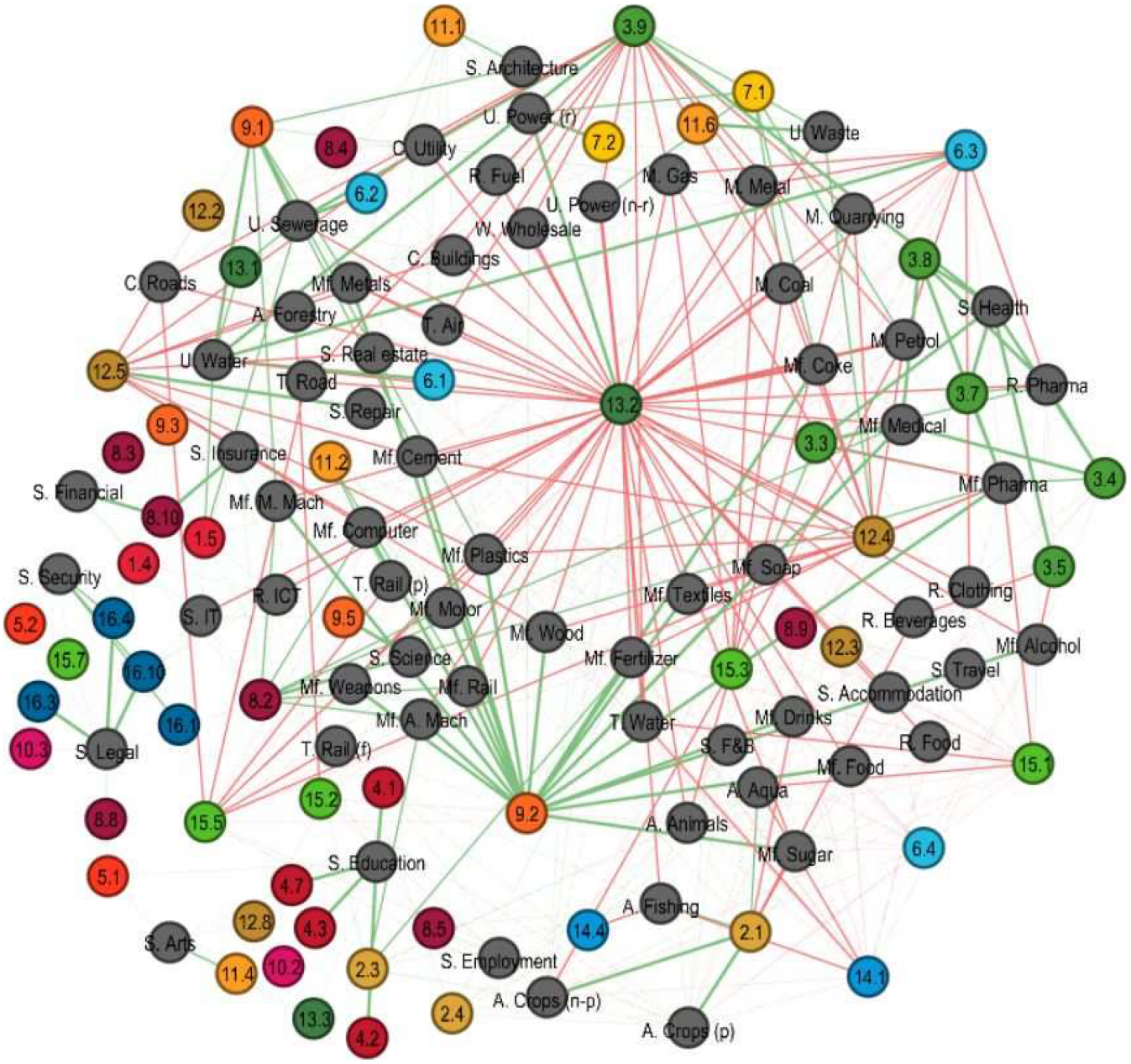

FIGURE 2 Full network of economic activities' (gray nodes) interactions with SDG targets (colored nodes) [Colour figure can be viewed at wileyonlinelibrary.com]

"manufacturing of basic pharmaceuticals" (k^{out} = 14). Figure 3 also clarifies which SDG targets are most central by receiving most influence from economic activities. The results indicate that target 13.2 (climate change mitigation) has the highest in-degree centrality, being influenced by 51 economic activities. Other SDG targets that have high in-degree centrality are 9.2 (promotion of industrialization; $k^{in}_{9.2} = 32$), 3.9 (reducing diseases from pollution; $k^{in}_{3.9} = 22$); 6.3 (reducing water pollution; $k^{in}_{6.3} = 21$), 15.1 (freshwater ecosystems; $k^{in}_{15.1} = 20$); and 14.1 (marine pollution; $k^{in}_{14.1} = 20$).

The centrality measures above give an indication of economic activities' overall influence on the SDGs. However, they do not distinguish between positive and negative interactions. To better understand how companies' economic activities influence the SDG Agenda, it is relevant to separately assess their positive and negative degree centralities.

We find that "Education," "Legal activities," and "Water collection, treatment and supply" have the highest positive (denoted by "+") out-degree centrality ($k^{out(+)}$ = 10). In terms of negative out-degree centrality (denoted by "−"), "Growing of non-perennial crops," "Animal production," and "Manufacture of wood and paper products" negatively interact with most SDG targets ($k^{out(-)}$ = 9). We also look at SDG targets' positive in-degree centrality. We find 9.2 (industrialization; $k^{in(+)}_{9.2} = 32$) to rank top, followed by 11.1 (urbanization and housing; $k^{in(+)}_{11.1} = 13$), 9.1 (infrastructure; $k^{in(+)}_{9.1} = 12$), and 8.2 (economic productivity; $k^{in(+)}_{8.2} = 12$), indicating these targets to be impacted by most economic activities. Negative in-degree centrality is highest for

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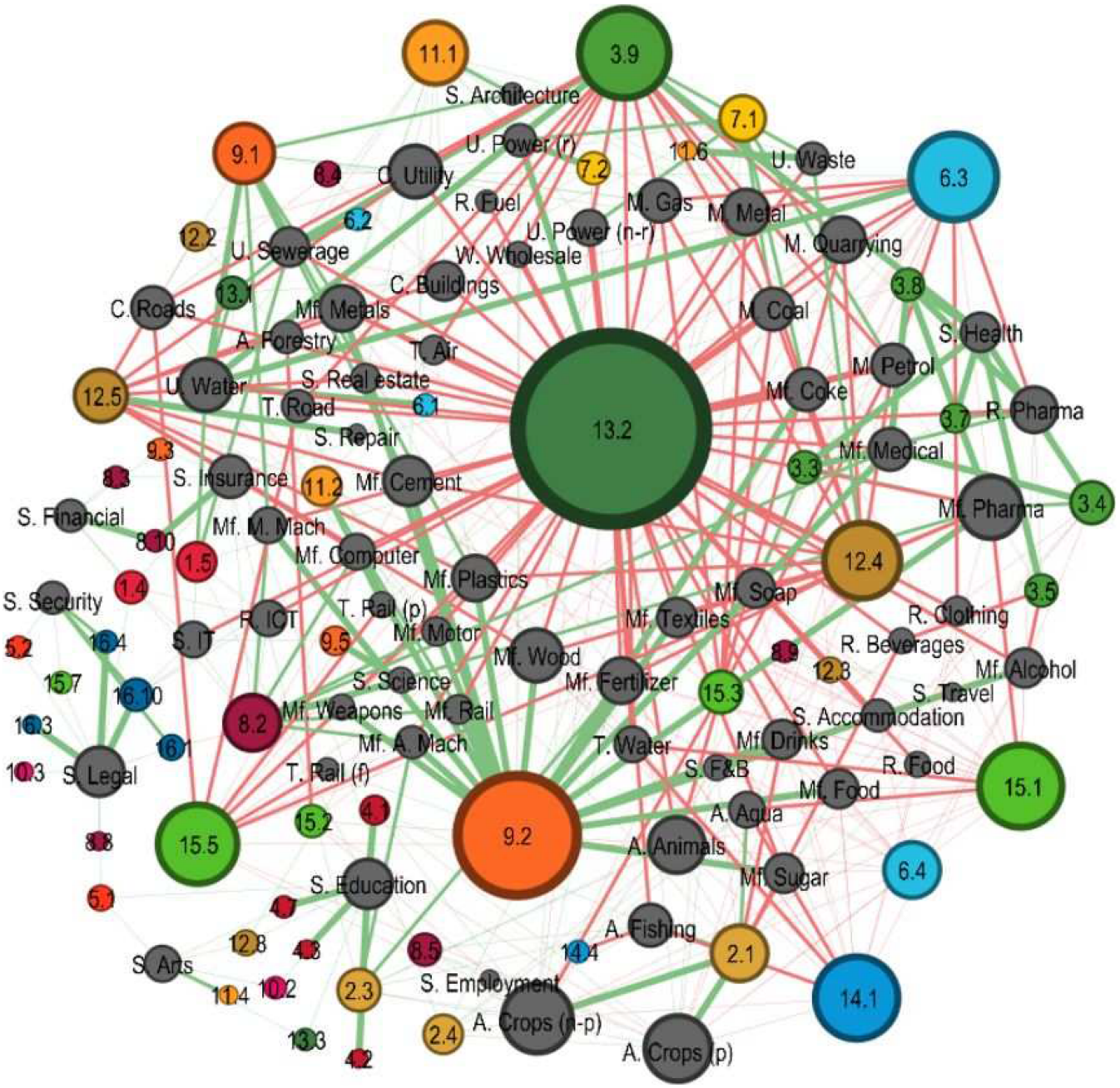

FIGURE 3 Centrality-adjusted network of interactions between economic activities and SDG targets [Colour figure can be viewed at wileyonlinelibrary.com]

13.2 (climate change mitigation; $k^{in(-)}_{13.2} = 49$), 15.1 (freshwater ecosystems; $k^{in(-)}_{15.1} = 20$), and 14.1 (marine pollution; $k^{in(-)}_{14.1} = 20$).

Whereas these results indicate which economic activities generate most positive/negative interactions with particular SDG targets (and vice versa), they do not speak to the strength of the interactions that were assigned. We therefore go one step further and also consider the scores that indicate the strength of the positive/negative interactions. We do so by creating sub-networks for the economic activities' positive interactions (Figure 4a–c) and negative interactions (Figure 5a–c) with SDG targets. Each figure consists of three sub-networks: one for each score that was assigned. We next explain the findings presented in each figure.

First, as displayed in Figure 4a, "growing of perennial crops" ($k^{out(+1)} = 7$), "legal activities" ($k^{out(+1)} = 7$) and "insurance" ($k^{out(+1)} = 7$) generate most *enabling* (+1) effects on SDG targets. In turn, SDG targets 9.2 (industrialization; $k^{in(+1)}_{9.2} = 12$) and 11.1 (urbanization; $k^{in(+1)}_{11.1} = 12$) receive most *enabling* (+1) effects. As shown in Figure 4a, these inward enabling effects arise in particular from transport, utilities, and mining activities. To briefly explain some of these interactions:

- Crop production can enable SDG targets related to agricultural productivity [2.3; 2.4], performance in schools [4.1] and in employment [8.5], and access to (renewable/biomass) energy [7.1; 7.2].

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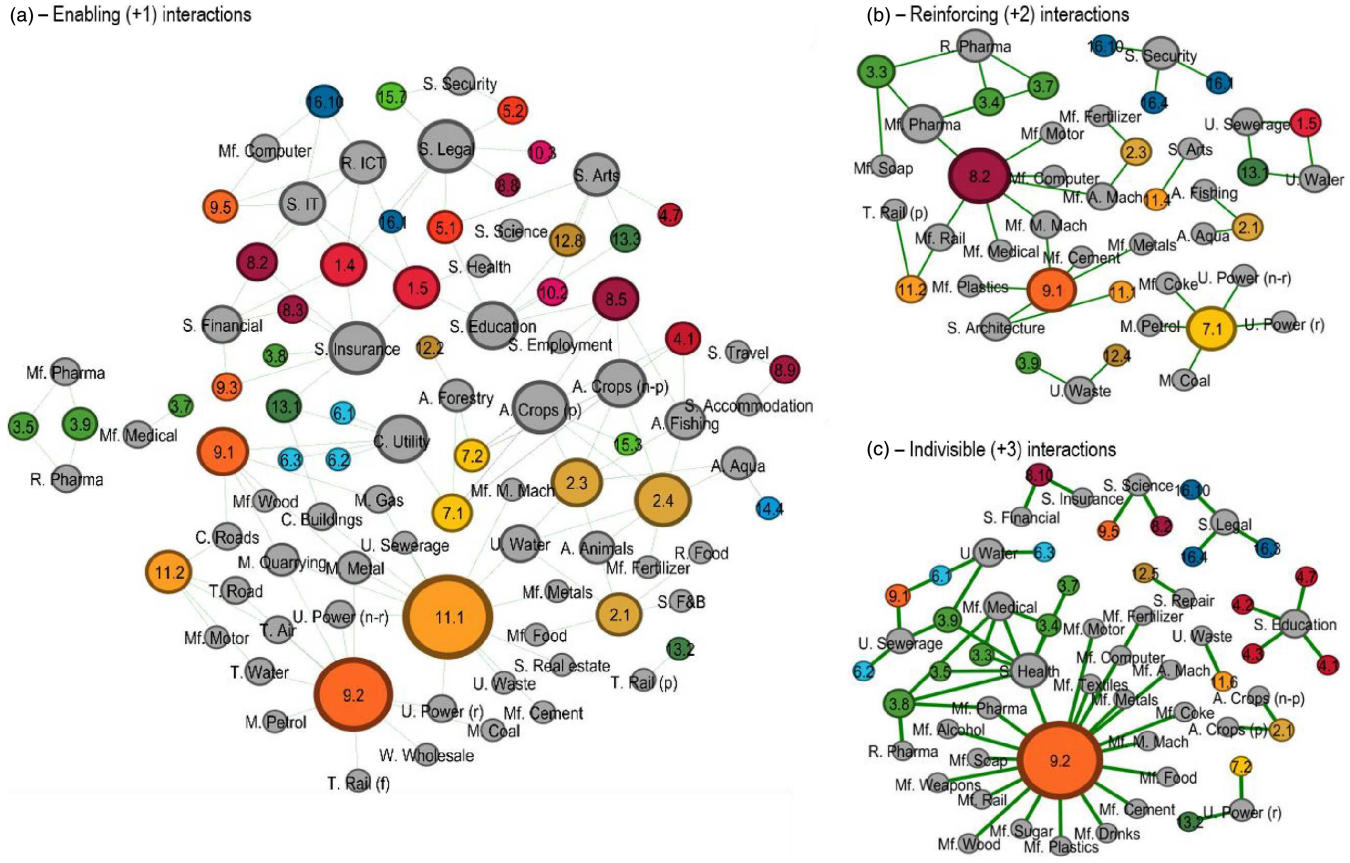

FIGURE 4 Positive interactions of economic activities on SDG targets [Colour figure can be viewed at wileyonlinelibrary.com]

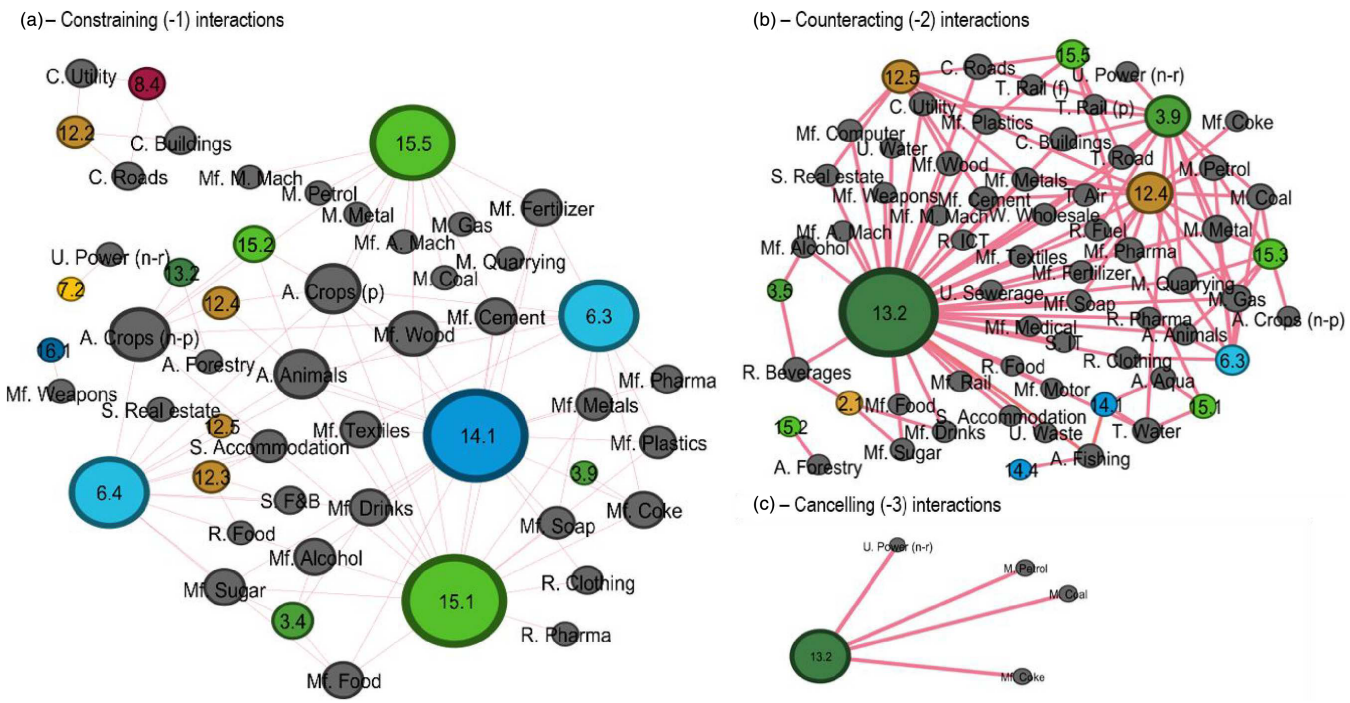

FIGURE 5 Negative interactions of economic activities on SDG targets [Colour figure can be viewed at wileyonlinelibrary.com]

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- Legal activities can enable the institutional requirements for sustainable development, especially in the context of poverty eradication [1.4], gender equality [5.1; 5.2], labor rights [8.8], discrimination [10.3], trafficking of species [15.7], and violence [16.1].
- Insurance can enable the poor to access financial services [1.4] and reduce people's vulnerability [1.5], for instance to climate-related hazards [13.1], it can enable access to health care [3.8], and may promote entrepreneurship [8.3] and growth more broadly [8.2].

Second, Figure 4b shows that "manufacturing of basic pharmaceuticals" ($k^{out(+2)} = 4$), "the retail sale of pharmaceutical and medical goods" ($k^{out(+2)} = 3$), and "security and investigation activities" ($k^{out(+2)} = 3$) generate the most *reinforcing* (+2) effects, the former two on targets related to good health and well-being [3.3; 3.4; 3.7], the latter on targets related to peace, justice and strong institutions [16.1; 16.4; 16.10]. SDG target 8.2, relating to economic growth, receives the most reinforcing effects $\left(k_{8.2}^{in(+2)} = 7\right)$, in particular from relatively sophisticated manufacturing activities. Target 7.1 (access to energy; $k_{7.1}^{in(+2)} = 6$) is reinforced by utilities, mining, and coke manufacturing activities. And target 9.1 (infrastructure; $k_{9.1}^{in(+2)} = 5$) is reinforced by cement, metals, plastics, and machinery manufacturing sectors, as well as by architecture services.

Third, *indivisible* (+3) interactions particularly arise when SDG targets explicitly call for the involvement of economic activities. As shown in Figure 4c, the many types of manufacturing activities in this study's scope are industrial activities and therefore, by their nature, indivisible from the promotion of industrialization [9.2] ($k_{9.2}^{in(+3)} = 20$). Economic activities causing the most indivisible interactions with SDG targets include "human health and social work activities" ($k^{out(+3)} = 6$) and "manufacture of medical and dental instruments and supplies" ($k^{out(+3)} = 4$), being entwined with good health and well-being (SDG 3). Moreover, "water collection, treatment and supply" ($k^{out(+3)} = 4$) is indivisible from water and sanitation (SDG 6), and "education activities" ($k^{out(+3)} = 4$) are inseparable from quality education (SDG 4).

We similarly investigated the negative interactions between economic activities and SDG targets. Again, we explain the findings for each of the three types of negative interactions between economic activities and SDG targets.

First, Figure 5a reveals that SDG targets 15.1 (freshwater ecosystems; $k_{15.1}^{in(-1)} = 20$), 14.1 (marine pollution; $k_{14.1}^{in(-1)} = 20$), 6.3 (water quality; $k_{6.3}^{in(-1)} = 19$), 15.5 (biodiversity; $k_{15.5}^{in(-1)} = 19$), and 6.4 (water scarcity; $k_{6.4}^{in(-1)} = 12$) receive the most *constraining* (−1) interactions from an array of agriculture, mining and manufacturing activities. "Growing of non-perennial crops" ($k^{out(-1)} = 8$), "growing of perennial crops" ($k^{out(-1)} = 7$), and "animal production" ($k^{out(-1)} = 7$) generate the most constraining interactions, followed by various manufacturing activities.

Second, Figure 5b reveals that SDG targets 13.2 (climate change mitigation; $k_{13.2}^{in(-2)} = 49$), 3.9 (deaths and illnesses from pollution; $k_{3.9}^{in(-2)} = 14$) and 12.4 (chemicals and waste; $k_{12.4}^{in(-2)} = 14$) receive the most *counteracting* (−2) effects. Fifty-two of the 67 economic activities included in this study generate counteracting effects on at least one SDG target. Economic activities creating the most counteracting effects are "mining of metal ores" ($k^{out(-2)} = 5$) and quarrying of stone, sand and clay ($k^{out(-2)} = 5$).

Third, SDG target 13.2 centers on climate change measures and refers to the 2015 Paris Agreement that aims to limit global warming to 1.5°C relative to pre-industrial times. Four economic activities in this study, "mining of coal and lignite," "extraction of crude petroleum," "manufacture of coke and refined petroleum products," and "non-renewable electric power generation," are so intensive in terms of their greenhouse gas emissions that they are not aligned with the intentions of the Paris Agreement, and therefore *cancel* (−3) SDG 13.2 (Figure 5c).

3.2.2 | Similarity: Which economic activities and SDG targets are most similar?

In addition to estimating how central economic activities and SDG targets are in this network, we can assess how similar they are. Similarity is useful because it allows us to identify allies: Pairs of economic activities may be similar in terms of impacting the same SDG targets, whereas pairs of SDG targets may be similar due to their being impacted by the same economic activities. If similarity between economic activities or among SDG targets is high, it implies that they share the same challenges in terms of improving positive and/or mitigating negative interactions. This may provide relevant insights for creating partnerships for the SDGs.

We took the following steps to ascertain which economic activities impact the same SDG targets, and which SDG targets are impacted by the same economic activities. First, we created one-mode projections of the bipartite (two-mode) network used in the foregoing analysis ((i.e., the network showing interactions between two groups of nodes: economic activities and SDG targets). These one-mode projections help study the similarity of nodes in each group by showing whether pairs of economic activities interact with an SDG target (and vice versa). Hence, we created a one-mode projection that counts the number of SDG targets that two economic activities both interact with by multiplying incidence matrix A with the transpose of incidence matrix A^T (so that $P = AA^T$). Similarly, we made a one-mode projection that counts the number of economic activities that two SDG targets are commonly impacted by, through calculating the matrix $Q = A^TA$. Whereas the result P is an 67×67 matrix—similar to an adjacency matrix—that shows the number of SDG targets that two economic activities both interact with, Q is a 59×59 matrix that shows the number of economic activities that two SDGs are both impacted by.

Second, we calculate a cosine similarity metric to investigate the relative similarity of pairs of economic activities and pairs of SDG targets. To explain, the created projections measure the similarity between the nodes in each of the two groups (i.e., economic activities and SDG targets) by simply counting total number of interconnections they share. This is a rough measure that is heavily influenced by the economic activities' and SDG targets' out-degree centrality: If they

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have more interactions, they have a higher likelihood of sharing similarities with other nodes. We therefore analyzed the similarity of economic activities and SDG targets by calculating their *cosine similarity*. The cosine similarity quantifies similarity between two nodes relative to the degrees (i.e., number of interconnections) of each node. The resulting metric ranges from 0 (two nodes have no interconnections in common) to 1 (two nodes interact with exactly the same nodes), thereby providing a normalized scale for measuring similarity. We calculated the cosine similarity for all pairs of economic activities and all pairs of SDG targets.

For a pair of economic activity nodes *i* and *j*, we calculated their cosine similarity:

$$\sigma_{ij} = \frac{\sum k P_{ik} P_{kj}}{\sqrt{k_i}\sqrt{k_j}},$$

and for each pair of SDG targets nodes *i* and *j*:

$$\sigma_{ij} = \frac{\sum k Q_{ik} Q_{kj}}{\sqrt{k_i}\sqrt{k_j}},$$

where *P* and *Q*, respectively, are the adjacency matrices that count the number of nodes economic activities (*P*) and SDG targets (*Q*) have in common.

The results indicate 1511 instances in which two economic activities both impact the same SDG target. Figure 6a visualizes the similarity of economic activities as a network, whereby an interaction (edge) between two economic activities (nodes) signals that they both impact at least one SDG target (hence, the figure visualizes 1511 edges). The width of the edges indicate the cosine similarity between two activities: The wider the edge, the more similar two economic activities are in their impacts on the SDGs. The size of the nodes signals economic activities' out-degree centrality. Their color relates to the overarching economic sector they are a part of. Similarly, Figure 6b shows 500 interactions between the 59 SDG targets in this study, indicating that two targets are both impacted by the same economic activity. The edges' widths indicate their cosine similarity; the nodes' sizes indicate their in-degree centrality.

On average, an economic activity has 45 other economic activities that interact with at least one similar SDG target. This ranges from a low of 1 ("travel agency services" and "accommodation" share one SDG target [8.9]) to a high of 57 ("manufacture of basic pharmaceuticals" interacts with SDG targets that 57 economic activities also interact with). The economic activities in the center of Figure 6, such as mining, construction, manufacturing and transport activities, interact with many SDG targets, leading them to share many similarities. The outer range contains economic activities, mostly in the services sector, that have fewer SDG interactions. Consequently, these economic activities have fewer instances in which they interact with the same SDG targets as other economic activities.

In contrast, an SDG target has an average of 17 other SDG targets that are influenced by at least one shared economic activity. SDG targets 8.9 (promoting sustainable tourism) and 11.6 (reducing the per capita environmental footprint of cities) both only have 4 SDG targets that are impacted by the same economic activities. In contrast, SDG target 13.2 (mitigating climate change) has 41 SDG targets that are impacted by at least one of the same economic activities. SDG targets 1.5 (building the resilience of the poor) and 6.3 (improving water

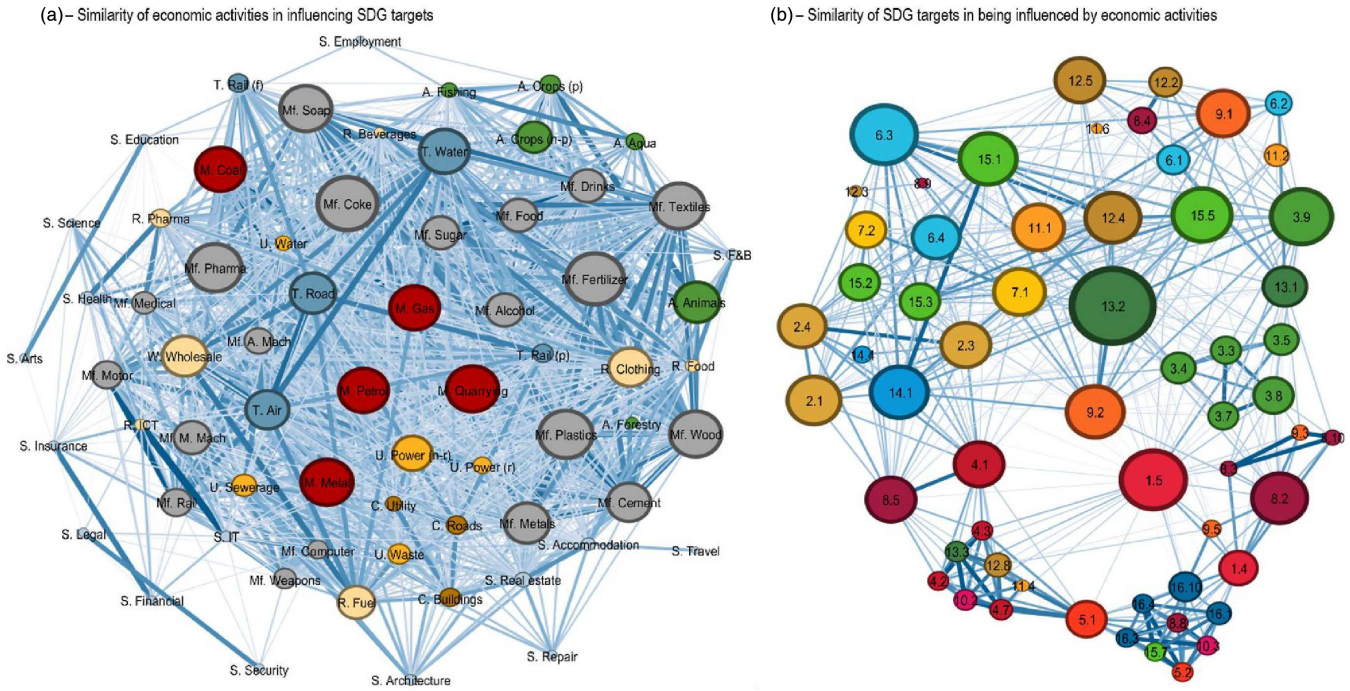

FIGURE 6 Similarity of economic activities (a) and of SDG targets (b) [Colour figure can be viewed at wileyonlinelibrary.com]

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quality by reducing pollution) both have 32 SDG targets that are impacted by at least one shared economic activity.

Adding to this, Figure 7 shows the adjacency matrix that reports the cosine similarity of two sectors (row and column). Likewise, Figure 8 shows the adjacency matrix that reports SDG targets' cosine similarities. In these matrixes, the colors correspond to the cosine similarity between two economic activities (Figure 7) or SDG targets (Figure 8). The following colors are used to signal similarity: dark green (high similarity; $\sigma_{ij} > 0.8$), light green (substantial similarity; $\sigma_{ij} > 0.6 < 0.8$), yellow (moderate similarity; $\sigma_{ij} > 0.4 < 0.6$), orange (slight similarity; $\sigma_{ij} > 0.2 < 0.4$), light gray (low similarity; $\sigma_{ij} > 0.01 < 0.2$), and dark gray (no similarity; $\sigma_{ij} = 0$).

Unsurprisingly, we find greater degrees of similarity along the diagonals in both figures, indicating that economic activities and SDG targets that ar

e more similar in type also are more similar in terms of SDG impacts. For instance, in Figure 7, we find high similarity among crop and animal production activities (Sectors 1–3), mining activities (Activities 7–11), manufacturing of different food types (Activities 12–16) and so forth. By the same logic, in Figure 8, we find that the targets under SDGs 2, 3, 4, 5, 7, 15, and 16 are relatively similar, and thus impacted by more of the same economic activities.

More surprising similarities were found away from the diagonals. For example, the manufacturing of pharmaceuticals (21) is seen to have similar SDG impacts to other manufacturing activities, including alcohol and tobacco (14), textiles (16), fertilizers, pesticides and other agrochemicals (19), medical and dental instruments and supplies (41), and to human health and social work activities (65). Hence, these similarities can be driven by shared positive effects (e.g., pharmaceutical manufacturing and human health activities both help advance targets related to good health and well-being—SDG 3), by mixed effects (e.g., pharmaceuticals advance SDG targets 3.4 and 3.5, whereas manufacturing alcohol and tobacco negatively interacts with these targets), or by negative effects (e.g., pharmaceutical manufacturing and textile manufacturing both face challenges in terms of SDG target 6.3—water pollution—and SDG target 12.4—chemicals and waste, among others). Looking at the similarity between SDG targets, it is found for instance that ending poaching and trafficking of biodiversity (15.7) is similar to eliminating violence against women and girls (5.2),

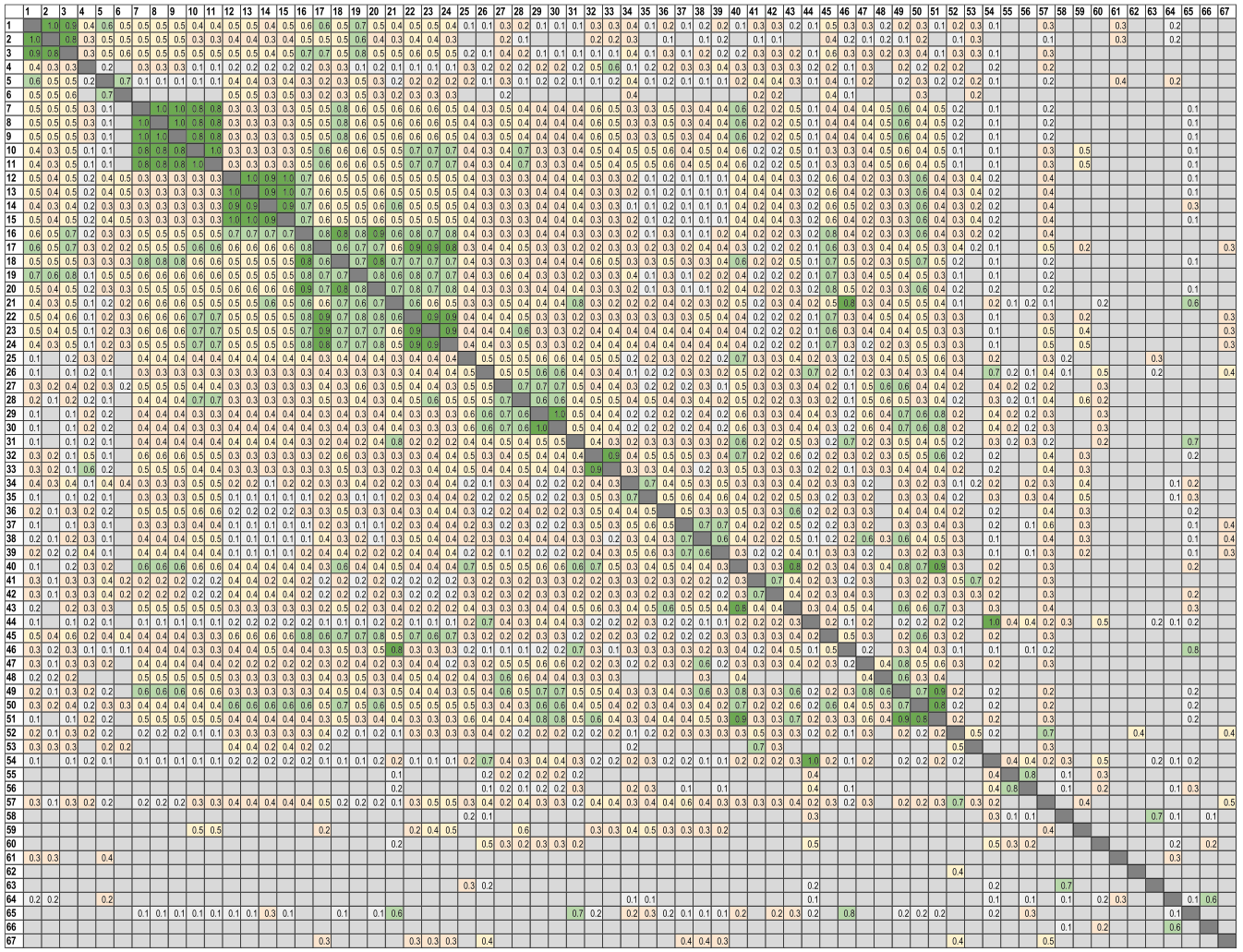

FIGURE 7 Cosine similarity of pairs of economic activities [Colour figure can be viewed at wileyonlinelibrary.com]

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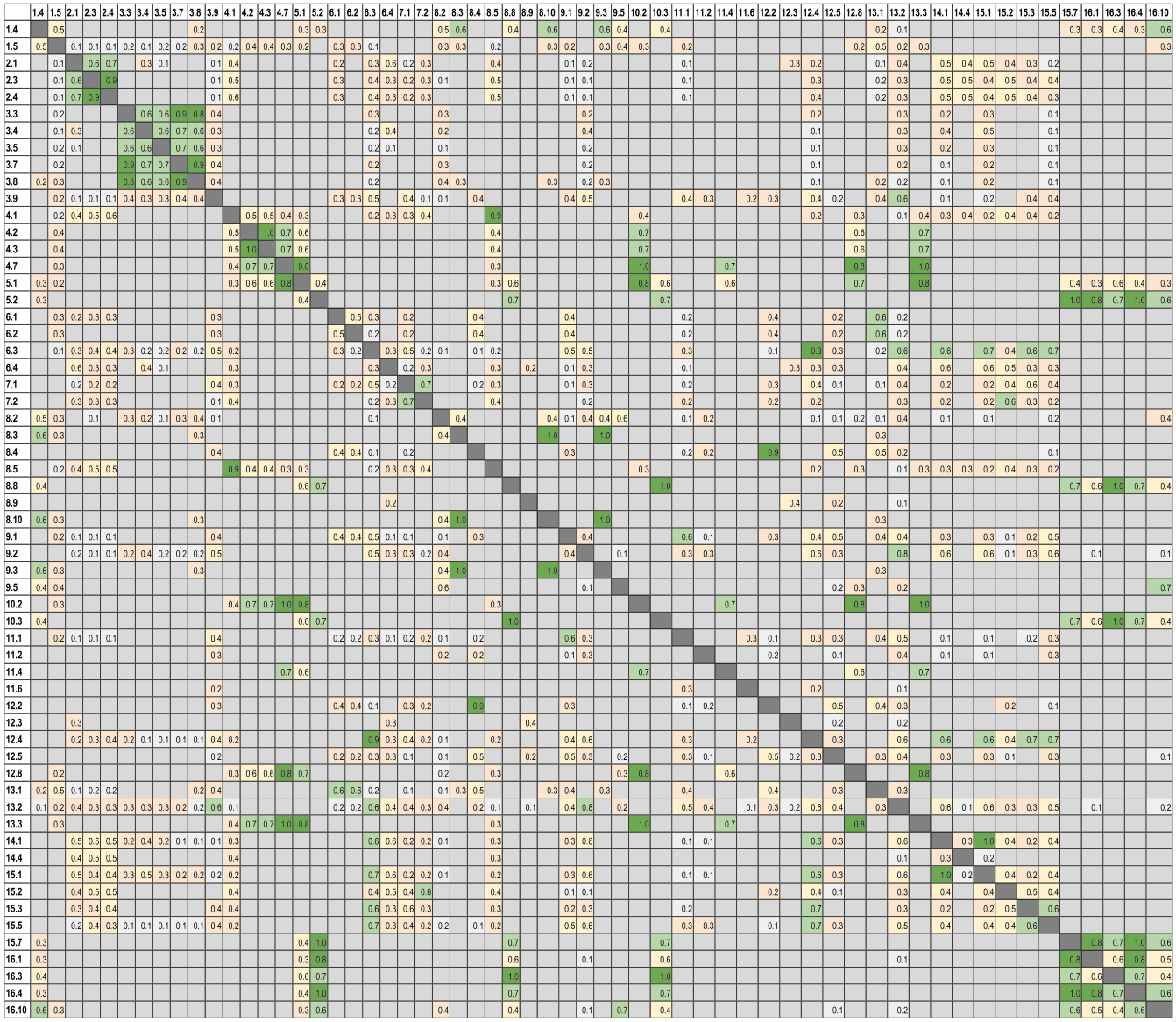

FIGURE 8 Cosine similarity of pairs of SDG targets [Colour figure can be viewed at wileyonlinelibrary.com]

protecting labor rights (8.8), ensuring equal opportunity (10.3), reducing violence (16.1), promoting the rule of law (16.3), reducing illicit financial and arms flows (16.4), and ensuring public access to information (16.10). The similarity across these SDG targets is driven primarily by "legal activities," which plays an enabling role in the achievement of these targets.

4 | IMPLICATIONS

4.1 | Strategic implications: Four groups of economic activities, four strategies

This study assessed to what extent individual economic activities are—positively and negatively—aligned with the SDG Agenda. Figure 9 summarizes the key findings. It organizes economic activities according to their positive (vertical axis) and negative (horizontal axis) influence on the SDG Agenda. The extent of these influences is determined by summing each economic activity's positive, as well as their negative, interactions with SDG targets. An economic activity's positive influence on the SDG Agenda is either low (score <4), moderate (score >3 < 6) or high (score >5). Negative influence is low (score <2), moderate (score >1 < 6) or high (score >5).[4] Hence, an economic activity can have a high (positive or negative) alignment with the entire SDG Agenda by having a few strong, or many less strong, interactions with the SDG targets.

Using this overview, we can categorize and strategize economic activities based on their alignment with the entire SDG agenda into four groups: core, mixed, opposed, and peripheral. We raise strategic sustainability imperatives for each of these groups.

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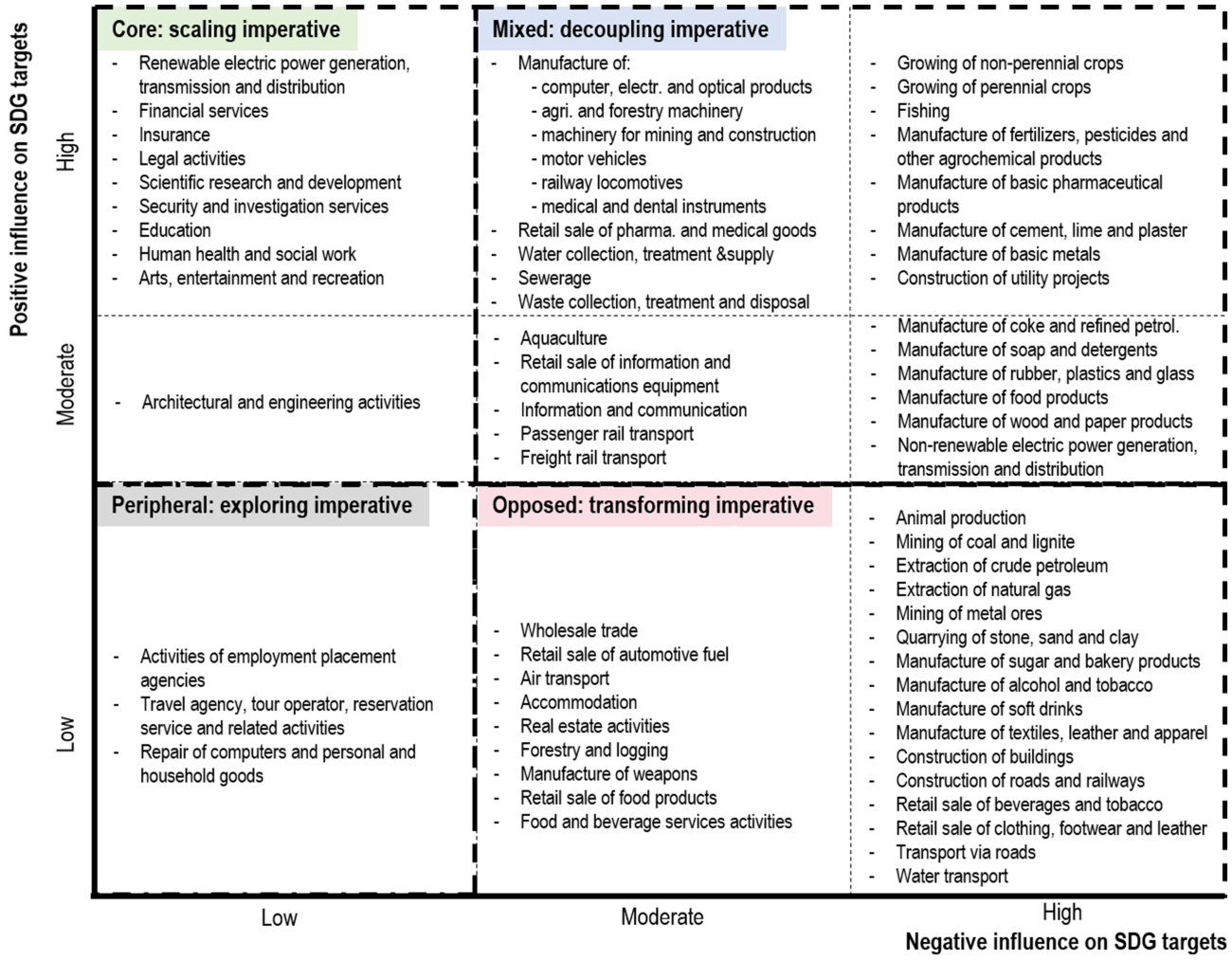
Positive influence on SDG targets
High
Moderate
Low
Core: scaling imperative
- Renewable electric power generation, transmission and distribution
- Financial services
- Insurance
- Legal activities
- Scientific research and development
- Security and investigation services
- Education
- Human health and social work
- Arts, entertainment and recreation
Mixed: decoupling imperative
- Manufacture of:
- computer, electr. and optical products
- agri. and forestry machinery
- machinery for mining and construction
- motor vehicles
- railway locomotives
- medical and dental instruments
- Retail sale of pharma. and medical goods
- Water collection, treatment &supply
- Sewerage
- Waste collection, treatment and disposal
- Growing of non-perennial crops
- Growing of perennial crops
- Fishing
- Manufacture of fertilizers, pesticides and other agrochemical products
- Manufacture of basic pharmaceutical products
- Manufacture of cement, lime and plaster
- Manufacture of basic metals
- Construction of utility projects
- Architectural and engineering activities
- Aquaculture
- Retail sale of information and communications equipment
- Information and communication
- Passenger rail transport
- Freight rail transport
- Manufacture of coke and refined petrol.
- Manufacture of soap and detergents
- Manufacture of rubber, plastics and glass
- Manufacture of food products
- Manufacture of wood and paper products
- Non-renewable electric power generation, transmission and distribution
Peripheral: exploring imperative
- Activities of employment placement agencies
- Travel agency, tour operator, reservation service and related activities
- Repair of computers and personal and household goods
Opposed: transforming imperative
- Wholesale trade
- Retail sale of automotive fuel
- Air transport
- Accommodation
- Real estate activities
- Forestry and logging
- Manufacture of weapons
- Retail sale of food products
- Food and beverage services activities
- Animal production
- Mining of coal and lignite
- Extraction of crude petroleum
- Extraction of natural gas
- Mining of metal ores
- Quarrying of stone, sand and clay
- Manufacture of sugar and bakery products
- Manufacture of alcohol and tobacco
- Manufacture of soft drinks
- Manufacture of textiles, leather and apparel
- Construction of buildings
- Construction of roads and railways
- Retail sale of beverages and tobacco
- Retail sale of clothing, footwear and leather
- Transport via roads
- Water transport
Low
Moderate
High
Negative influence on SDG targets

FIGURE 9 Strategic needs based on the alignment of companies' economic activities with the SDGs [Colour figure can be viewed at wileyonlinelibrary.com]

4.1.1 | Core activities: The imperative to scale

These are economic activities that have a high (or moderate) degree of positive and a low degree of negative interactions with the SDG targets. Many of these activities provide public goods: "education," "human health and social work," "arts, entertainment and recreation," "legal activities," "security and investigation services," and "scientific research and development" contribute to quality education (SDG 4), good health and well-being (SDG 3), reduced inequalities (SDG 10), and peace, justice and strong institutions (SDG 16). They help deliver critical components of well-being. Moreover, "renewable electric power generation, transmission and distribution," helps people gain access to clean energy (SDG 7) and enables societies to mitigate climate change (SDG 13). In turn, activities like "financial services," and "insurance" contribute to spreading access to financial services (SDG 1), including for (small-to-medium-sized) enterprises (SDGs 8 and 9).

Hence, these activities are core to the SDG Agenda: They deliver key components of sustainable development while having few negative externalities. For companies undertaking such activities, the strategic imperative is to expand and scale, thereby exploiting their present business models.

4.1.2 | Mixed activities: The imperative to decouple

These economic activities have a moderate/high degree of both negative and positive interactions with the SDG targets. These activities play a particularly important role for achieving SDGs focused on health (SDG 3), water and sanitation (SDG 6), decent jobs and economic growth (SDG 8), infrastructure, industrialization and innovation (SDG 9), and sustainable cities (SDG 11). Yet they cause significant negative externalities that predominantly cause environmental pollution (SDGs 6, 12, 13, 14, and 15) which poses risks to human health (SDG 3). For instance, growing of crops provide staple foods that are key to nutritious diets (SDG 2) but also have a high degree of negative interactions, including on water use (SDG 6), chemical use (SDG 12), and land degradation (SDG 15).

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Due to their moderate/high positive interactions with the SDG targets most of the economic activities in this category cannot be missed in a sustainable future. This brings the challenge of "decoupling" their negative impacts. Exploring ways of managerial and technological innovation for decoupling adverse impacts from their positive contributions should thus rank high on the agenda of companies undertaking these activities.

4.1.3 | Opposed activities: The imperative to transform

These economic activities have a low degree of positive, and a moderate/high degree of negative interactions with the SDG targets. Their few positive, together with their significant negative, interactions with the SDGs leads these economic activities to have a potentially strong influence on holding back—or even reversing—progress on the SDGs. Examples include the high negative impacts of "mining of coal and lignite," "extraction of crude petroleum," "mining of metal ores" and "quarrying of stone, sand and clay" on the natural environment (SDGs 6, 12, 13, 14, and 15). Another example is the adverse impacts on human health (SDG 3) of "manufacture of alcohol and tobacco" or "manufacture of soft drinks," which additionally use significant volumes of water (SDG 6).

The strategic imperative for companies whose economic activities are *opposed* to the SDG Agenda is to "transform" in order to abandon economic activities negatively aligned with the SDGs, and shift towards activities with positive alignment. An example is Danish oil and gas company DONG, which transformed itself into a renewable energy company, changing its name to Ørsted. Hence, Ørsted transformed from an "opposed" into a "core" company for the SDGs. Similar transformations may be used to avoid the negative SDG impacts of "animal production," simply by switching production to deliver plant-based alternatives. However, in various cases such alternatives may not be feasible, while the positive effects might still be deemed desirable. In such cases, options must be created that provide positive effects but mitigate negatives (e.g., "construction of buildings" is important for creating sustainable cities (SDG 11) yet it is imperative to do so in a sustainable manner that uses resources efficiently (8.4), avoids waste (SDG 12) and reduces GHG emissions (SDG 13)). Another example concerns mining activities, where the attention is moving from the life cycle of the mine to the life cycle of the mineral, thus incorporating principles of circularity that enable long-term sustainability (e.g., Gorman & Dzombak, 2018).

4.1.4 | Peripheral activities: The imperative to explore

These economic activities have a low degree of positive as well as negative interactions with the SDG targets. These *peripheral* economic activities are relatively less relevant for achieving the SDG Agenda: They contribute little yet are also not expected to cost a lot. The strategic imperative is to "explore", in order to actively seek innovative opportunities for generating positive impacts.

4.2 | Policy implications: Towards a nexus approach for the SDGs

Amidst slow progress (UN, 2020) and a fast approaching deadline, policymakers face an urgent need to accelerate action on the SDGs. Scholars are helping by conducting research that provides evidence-based tactics that (more) effectively advance the SDGs.

One approach that is gaining ground is the "nexus approach." The nexus approach recognizes that the SDGs are interconnected: Positive interactions signal that one SDG improves progress on another, while negative interactions indicate that progress on one goal deteriorates progress on another. The nexus approach then stimulates policymakers to direct their efforts to the interconnections between the SDGs rather than on the goals themselves. It thereby offers opportunities for advancing multiple goals simultaneously (i.e., generating co-benefits) and reducing the risk that SDG policies undermine each other (i.e., avoiding trade-offs) (see, e.g., Allen et al., 2019; Boas et al., 2016; Liu et al., 2018; Waage et al., 2015; Weitz et al., 2014). A consequence is that the nexus approach can identify possibilities for reducing costs, generating bigger impacts across wider scales, and restraining vicious interactions that generate undesirable outcomes, which can evaporate investments. Additionally, a nexus approach can help identify which stakeholders are "winners" and "losers" of particular policies, and which can help accelerate—as opposed to impair—the proposed sustainable development pathways (Nilsson et al., 2018). Although there are concerns that the "nexus" is at risk of becoming a buzzword (Nature, 2016), its traction in both policy and research circles holds potential for accelerating progress towards achieving the SDGs (Bleischwitz et al., 2018). While the interactions between themselves are increasingly being studied (for a review, see, e.g., Bennich et al., 2020), we think it is also critical to improve our understanding of how different types of human activities set these SDG interactions in motion in the first place.

In this context, we propose that policymakers can use the economic activities that companies undertake as a lever for operationalizing a nexus approach to the SDGs. To date, the nexus approach has been primarily discussed concerning its potential for increasing efficiency, not in terms of its implementation. Our network analyses offer insights into the expected positive and negative impacts of economic activities which allows policymakers to promote economic activities that advance particular priority-SDGs and regulate or restrain economic activities that hamper progress on SDGs. For instance, to combat pollution (SDG 12) policymakers may want to promote activities like "water collection, treatment and supply," "sewerage" and "waste collection, treatment, and disposal activities." The detailed network diagrams that we presented offers guidance for using economic activities to create positive impacts and reduce negative impacts. This aligns with a key conclusion of the 2019 Global Sustainable Development Report, an independent scientific assessment

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that informs the UN General Assembly on the implementation of the SDGs: "Economic activity should be seen not as an end in itself, but rather as a means for sustainably advancing human capabilities. Decoupling the benefits of economic activity from its costs at all levels is essential in itself and can also support the systemic transformations [that] help to put people, societies and nature on the path to sustainable development" (Independent Group of Scientists appointed by the Secretary-General, 2019:24). Relatedly, now that there are strong national policy responses to the COVID−19 pandemic, there is an excellent opportunity for advancing those economic activities (meso-level) and companies (micro-level) that advance sustainable development, and avoid investing in those that hold back progress (e.g., van Zanten & van Tulder, 2020b). Amidst this pandemic, UNCTAD (2020:14) for instance is calling for managing "the multiple and changing nexuses between trade and development." The network analysis presented in this paper can provide inputs to this objective.

In using companies' economic activities as a way to promote SDG targets, opportunities for creating bigger impacts across wider scales are found in similarity. We identified which economic activities are most similar in terms of their impacts on the SDG Agenda. We also identified which SDG targets share the greatest similarities in terms of being impacted by the same economic activities. The matrixes in Figures 7 and 8 provide "heat maps" that reveal these degrees of similarity. From a corporate, bottom–up perspective, there is a clear rationale for companies undertaking similar economic activities to partner together on sustainability: They face the same opportunities, or challenges, in terms of their SDG impacts, which stand to be improved, or mitigated, by working together. From a policy, top–down, perspective, the similarity of indicators across SDG targets prove relevant. More similar SDG targets can be advanced together, by improving/reducing the positive/negative impacts of the economic activities that are influencing them (and thus causing their similarity).

4.3 | Limitations

Our study faces limitations yet opens avenues for future research. First, our approach is similar to the methods used by Weitz et al. (2018) in their assessment of interactions between 34 SDG targets in the context of Sweden. Whereas our scope is different and broader, our study also confronts a same subjectivity-related limitation. A degree of subjectivity is inherent to defining and scoring interactions between economic activities and SDG targets. We intended to mitigate this risk by grounding our establishment of interactions between economic activities and SDG targets in a systematic-type review of extant literature (van Zanten & van Tulder, 2020a), and by verifying the defined interactions with multiple experts. Yet differences in defining and scoring interactions might be obtained by other researchers.

A second limitation concerns the lack of granularity contained in our independent variable. We investigated the interactions between a set of economic activities, as listed in international classifications (with certain modifications), and the SDGs' underlying targets. The benefit of this approach, which we pursued, is that these economic activities are used and documented by data provided (as mentioned earlier) and by international organizations. For instance, the EU Sustainable Finance Action Plan, one of the most significant regulatory developments in sustainable finance (e.g., EU Technical Expert Group on Sustainable Finance, 2020), is fully focused on the degree of sustainability of the economic activities that companies undertake, using a very similar list of economic activities as the one included in this paper.[5] Despite this linkage with international statistical systems, and although we intended to retain as much detail in the economic activities that we used as possible, this approach lacks granularity in that it does not capture the performance of the companies that undertake them. Yet management matters: Different companies undertaking the same economic activity, while their expected positive and negative impact areas are similar, may vary widely in terms of the extent of their impacts.

Future research avenues lie in the adaptation of companies to their environment. There is consensus that companies that are successful in meeting today's demands while being simultaneously able to explore and adapt to changes in their environment are likely to be more successful in the future. Sustainable development presents unprecedented changes in companies' environments. We attempted to make a step towards understanding the degree of alignment between companies and their sustainable development environment—as conceptualized by the SDGs. More specifically, future research can build on this study by (i) investigating how the management of economic activities by individual companies can transform the many neutral interactions (89% of all 3514 interactions assessed in this study) into positive ones (i.e., many SDGs, such as Gender Equality or Peace, Justice, and Strong Institutions, can be advanced through management, yet were considered outside of the scope for this study); (ii) assessing how the impacts of companies on the topics of the SDGs is influencing survival (i.e., are companies that are more aligned with the SDG Agenda also financially more successful?); (iii) quantifying the environmental and social impacts of companies (i.e., to what extent do companies help attain the SDGs?); and (iv) defining strategies for improving the alignment between companies and the SDGs (i.e., how can companies improve their positive—and reduce their negative—impacts on the SDGs?). In answering such questions, theoretically embedded and practically relevant frameworks, such as the "business responsibility matrix" of Sinkovics et al. (2021), and the "nexus approach" to the SDGs (e.g., Bleischwitz et al., 2018), hold potential for delivering robust insights that resonate in the scholarly domain while being actionable in the public and private sectors.

5 | CONCLUSION

Successful companies are able to adapt to changes in their environment. The global adoption of the SDGs in 2015 presents a major change in the institutional environment in which companies operate. All countries now aim to achieve 17 SDGs with 169 targets by 2030.

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And they call upon companies to help achieve these goals. This makes aligning with the SDGs, by improving positive and reducing negative impacts, a key strategic sustainability challenge for companies. However, companies are not homogenous, nor are their activities. Different companies engage in different activities, like farming, mining, marketing, or financing. Since these different activities vary in their impacts on the SDGs, tackling this strategic challenge depends on the nature of the activities a company is engaged in.

In this paper, we explored how the numerous economic activities that companies may undertake—often at the same time—have different degrees of alignment with the SDGs. Building on an extensive literature review, an assessment of the SDGs' targets, and interviews with experts, we identified and scored the extent to which 67 economic activities—which includes companies' operations and the goods and services they produce—are expected to positively and negatively interact with 59 SDG targets. These interactions were analyzed using network analysis. The findings revealed detailed measures of *centrality* and *similarity*: (i) which economic activities are most central in terms of impacting most SDG targets, (ii) which economic activities are similar in terms of impacting the same SDG targets, (iii) which SDG targets are most central by being most frequently impacted by economic activities, and (iv) which SDG targets are most similar by virtue of being impacted by the same economic activities.

Overall, we categorized economic activities into four types, each facing a strategic sustainability imperative. First, activities that are *core* to the SDG Agenda have many positive and few negative interactions with SDG targets. For such activities, the strategic imperative is to exploit their present business models to "scale" positive impacts. Second, activities that play a *mixed* role have a moderate/high degree of both negative/positive interactions with SDG targets. The strategic imperative is to improve alignment by "decoupling" positive from negative impacts. Third, activities that are *opposed* to the SDG Agenda provide few benefits yet cause significant adverse impacts. The strategic imperative for such companies is to "transform" in order to abandon economic activities negatively aligned with the SDGs, and shift towards activities with positive alignment. Fourth, *peripheral* activities have few positive as well as negative impacts on the SDG Agenda, causing the strategic imperative to be to "explore" options for creating positive impact.

We presented detailed network diagrams that show which SDG targets stand to receive further positive impacts, and which SDG targets face negative impacts that must be reduced. These network diagrams can serve as guideposts for improving companies' alignment with the SDG Agenda. We also identified which economic activities are similar in terms of impacting SDG targets (and vice versa). Similar economic activities can partner to tackle the sustainability challenges they both face.

If firms manage to improve their alignment with the whole SDG Agenda—rather than with individual SDGs only—their sustainability strategies will be more successful and their ambition to create "shared value" embedded in a more sophisticated measurement approach. This not only helps them achieve their sustainability objectives, it also contributes to creating a more stable and inclusive world in which companies can grow along sustainable pathways. And while policymakers still primarily adopt a top–down, macro-level, perspective towards the SDGs, they too stand to benefit from acknowledging the diverse impacts companies' economic activities have on sustainable development. These activities can be used as a lever for advancing particular groups of SDGs. Integrating and strategizing multiple levels of analysis makes policies for the SDGs somewhat more complex, but also holds serious potential for accelerating progress. With less than 10 years left to achieve the goals, further research on the role of companies in implementing the SDG Agenda is a logical next step for progress.

DECLARATIONS

The first author is employed by Robeco, an asset management firm with its headquarters in Rotterdam, the Netherlands. The views expressed in this paper are not necessarily shared by Robeco.

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ENDNOTES

[1] Corporate sustainability is a contested concept. In this paper, we liberally and inclusively use the term "corporate sustainability" to indicate the ways in which companies engage with and manage their impacts on sustainable development.

[2] In principle, interconnections between economic activities are bi-directional (i.e., an economic activity influences, and is influenced by, an SDG target). In this study, we only assess the uni-directional interactions between economic activities and SDG targets (i.e., the influence of an economic activity on an SDG target, but not vice versa).

[3] Gephi is "the leading visualization and exploration software for all kinds of graphs and networks". See: https://gephi.org/

[4] We set lower, more stringent, thresholds for negative impacts, in line with the precautionary principle in sustainability.

[5] The European Union classifies economic activities in its Statistical Classification of Economic Activities in the European Community, which is referred to as NACE (Nomenclature Statistique des Activités Économiques dans la Communauté Européenne). NACE can be understood as the European implementation of the UN's ISIC Rev 4 classification.

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